



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : A61L 2/18, A01N 37/16 // A61L 101/22	A1	(11) International Publication Number: WO 00/30690 (43) International Publication Date: 2 June 2000 (02.06.00)
(21) International Application Number: PCT/US99/27699 (22) International Filing Date: 22 November 1999 (22.11.99) (30) Priority Data: 60/109,565 23 November 1998 (23.11.98) US (71) Applicant: ECOLAB INC. [US/US]; Ecolab Center, 370 Wabasha Street North, St. Paul, MN 55102-1390 (US). (72) Inventors: RICHTER, Francis, L.; 6707 Sherman Lake Road, Lino Lakes, MN 55038 (US). REINHARDT, Duane, J.; 2376 Mailand Road, Maplewood, MN 55119 (US). SWART, Sally, K.; 1593 112th Court West, Inver Grove Heights, MN 55077 (US). (74) Agent: SORENSEN, Andrew, D.; Ecolab Inc., 840 Sibley Memorial Highway, Mendota Heights, MN 55118 (US).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: NON-CORROSIVE STERILANT COMPOSITION (57) Abstract <p>A non-corrosive, liquid, aqueous sterilant composition (as a concentrate or ready-to-use solution), which may be provided in two parts which are mixed prior to application, may comprise a peracid (in an equilibrium solution with an underlying carboxylic acid or mixtures of alkyl carboxylic acids and peroxide), inorganic buffering agent, and water. It has been found that the use of this simplified system, even in the absence of additional components which have been thought to be desirable for sterilants used on metal parts (e.g., copper and brass corrosion inhibitors, chelating agents, anti-corrosive agents) display excellent performance and that these additional components are not necessary, and that the presence of these additional materials at least complicates disposal of the spent solutions and could complicate compatibility of the sterilant solutions with some polymeric materials, especially where organic materials are used as the additional components, which organic materials may interact with, dissolve or solubilize in the polymeric materials.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

NON-CORROSIVE STERILANT COMPOSITION

5 The present invention relates to compositions which can be used to safely and effectively disinfect surfaces and articles against microbiological forms. The compositions are easily handled, tend to be non-corrosive to the types of polymeric, elastomeric and metal surfaces found in medical instruments, are relatively shelf-stable, and may be prepared quickly and easily by simply blending component solutions.

10 The importance of the sterilization of medical instruments and implants has been understood for more than two centuries. The need for sterilization has become even more important recently with the appearance of strains of microbiological forms which are resistant to conventional microbiocides such as antibiotics. It has become very important to sterilize medical devices to kill or
15 remove the more resistant strains of microbiological forms before they infect a patient. Additionally, the sterilants must be generally effective against microorganisms covering a wide range of classes and species, with U.S. Government standards requiring efficacy against both bacteria and spores.

20 Sterilization of medical devices has been performed for many years by immersing the medical devices in an atmosphere which is antagonistic to the survival of the microbiological forms. Among the environments which have been used to attempt to sterilize medical instruments include, but is not limited to, steam, alcohols, ethylene oxide, formaldehyde, gluteraldehyde, hydrogen peroxide, and peracids. Each of these materials has its benefits and limitations.
25 Ethylene oxide tends to be very effective against a wide range of microorganisms, but it is highly flammable and is generally used in a gas phase which may require more stringent environmental restraints than would a liquid. Alcohols are similarly flammable and must be used in very high concentrations. Steam has a more limited utility, having to be used in a controlled and enclosed
30 environment, requiring the use of large amounts of energy to vaporize the water, and requiring prolonged exposure periods to assure extended high temperature contact of the steam with the organisms. Hydrogen peroxide has limited applicability because it is unstable and not as strong as some other sterilants.

The peracids have become more favorably looked upon, but they tend to be corrosive (being an oxidizing acid) and are not shelf stable.

U.S. Patent No. 5,508,046 describes a stable, anticorrosive peracetic acid/peroxide sterilant comprising a concentrate including peracetic acid, acetic acid, hydrogen peroxide (in a ratio of 1:1 to 11:1 total acid/hydroxide), and 0.001 to 200 parts per million of stabilizers such as phosphonic acids and sodium pyrophosphates. The concentrates are diluted about 20 to 40 times so that the maximum concentration of stabilizer in the use solution would be about 10 parts per million. The stabilizers are described as acting as chelating agents by removing trace metals which accelerate the decomposition of the peroxides.

U.S. Patent No. 5,616,616 describes a room temperature sterilant particularly useful with hard tap water comprising an ester of formic acid, an oxidizer (such as hydrogen peroxide or urea hydrogen peroxide), performic acid and water. The use of corrosion inhibitors (such as benzotriazoles, azimidobenzene, and benzene amide) and stabilizers (unnamed) is also generally suggested.

U.S. Patent No. 5,077,008 describes a method of removing microbial contamination and a solution for use with that method. The solution comprises a combination of five ingredients in water: 1) a strong oxidant (including, for example, organic peroxides, peracids, an chloride releasing compounds, with peracetic acid in a concentration of 0.005 to 1.0% being preferred), 2) a copper and brass corrosion inhibitor (e.g., triazoles, azoles and benzoates), 3) a buffering agent (including, for example, phosphate), 4) at least one anti-corrosive agent which inhibits corrosion in at least aluminum, carbon steel and stainless steel selected from the group consisting of chromates and dichromates,, borates, phosphates, molybdates, vanadates and tungstates, and 5) a wetting agent. A sequestering agent may be used to prevent the phosphates from causing precipitation in hard water.

U.S. Patent Nos. 4,892,706 and 4,731,22 describe automated liquid sterilization systems having a plurality of modules which store the sterilant solution and the rinse solution. U.S. Patent No. 5,037,623 describes a sterilant concentrate injection system which is a spill resistant, vented ampule system for use with sterilization systems.

Medical devices now include many polymeric components for reasons of material costs and ease of manufacture. Many of the systems and solutions designed for the sterilization of metal medical devices are not necessarily suitable for use with polymeric components, and may cause corrosion of the polymeric materials. It is therefore necessary to formulate sterilization compositions which are compatible with both metal and polymeric components of the medical devices. It is also always desirable to provide sterilization systems with fewer components in the composition, where the sterilization solutions do not significantly sacrifice microbiocidal activity and do not corrode the materials used in medical devices.

SUMMARY OF THE INVENTION

A non-corrosive, liquid, aqueous sterilant composition (as a concentrate or ready-to-use solution), which may be provided in two parts which are mixed prior to application, may comprise a peracid (in an equilibrium solution with an underlying carboxylic acid or mixtures of alkyl carboxylic acids and peroxide), inorganic buffering agent, and water. It has been found that the use of this simplified system provides excellent sterilization ability, even in the absence of additional components which have been thought to be desirable for sterilants used on metal parts (e.g., copper and brass corrosion inhibitors, chelating agents, anti-corrosive agents) which have been found to not be necessary. The presence of these additional materials at least complicates disposal of the spent solutions and could complicate compatibility of the sterilant solutions with some polymeric materials, especially where organic materials are used as the additional components, which organic materials may interact with, dissolve or solubilize in the polymeric materials.

The concentration of the components has shown itself to be important in providing non-corrosive effects towards a wide variety of structural materials in medical devices and yet providing effective sterilization effects against spores and bacteria, including tuberculosis bacteria in an acceptable amount of time.

An aqueous sterilant use solution according to the present invention may comprise a solution having a pH of from 5.0 to 7.0 comprising from 100 to 10,000 parts per million of a peroxy acid and 30 to 5000 parts per million of buffering agent, preferably without any organic anticorrosive agents. The

aqueous sterilant solution may, for example, comprise from 100 to 10,000 parts per million of a peroxy acid, 30 to 5000 parts per million of buffering agent and a catalytically effective amount of a catalyst for peroxygenation of a carboxylic acid by hydrogen peroxide.

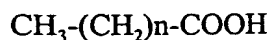
5 The aqueous sterilant solution may consist essentially of a solution having a pH of from 5.0 to 7.0 comprising from 100 to 10,000 parts per million of a peroxy acid, 30 to 5000 parts per million of buffering agent and a catalytically effective amount of a catalyst for peroxygenation of a carboxylic acid by hydrogen peroxide.

10 The method may particularly comprise mixing a first and a second solution to form a sterilizing solution comprising a peroxy acid, said first solution comprising a carboxylic acid, hydrogen peroxide and water, and said second solution comprising a buffering agent for pH between about 5 and 7, said sterilizing solution comprising at least 100 parts per million of peroxy acid at a
15 pH of 5 to 7, immersing said article in said sterilizing solution for at least 5 minutes to sterilize said article, said first solution and second solution being free of organic anti-corrosion agents for brass and/or copper, and said article comprising a medical article having parts made of at least two materials selected from the group consisting of metals, polymers and rubbers.

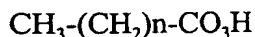
20 **DETAILED DESCRIPTION OF THE INVENTION**

 The aqueous sterilant compositions of the present invention comprise a peracid, water-soluble peroxide source, and carboxylic acid in a buffered solution at pH levels between about 5.0 and 7.0. The use of an inorganic buffering agent also enables the use of slightly water-soluble, higher molecular
25 weight carboxylic acids in the formation of peroxy acids with the peroxide source thereby reducing the amount of deposits from fatty acid residue in the solution. Phosphate buffers are effective dispersants and suspending agents for these fatty acid residues.

 The peroxy acid useful in the practice of the present invention may
30 comprise any organic peroxy acid. These acids are well known in the art to be formed from any carboxylic acid containing compound. Normally they are prepared from carboxylic acids of the formula:



wherein n is 0 to 18, preferably 0 to 12 and more preferably 0 to 10, with the corresponding peroxy acid having the formula:



- 5 wherein n is as defined above. The alkyl moiety on the acid, $\text{CH}_3-(\text{CH}_2)_n-$ may be replaced with hydrogen or any, preferably low molecular weight, organic group so that the acid and the resulting peroxy acid may be represented by: $\text{R}-\text{CO}_2\text{H}$ and $\text{R}-\text{CO}_3\text{H}$, respectively. The molecular weight of R could be 1, but preferably should be between 15 and 155.

10

Carboxylic acids which are generally useful in the invention are those which comprise percarboxylic acids. Percarboxylic acids generally have the formula $\text{R}(\text{CO}_3\text{H})_n$,

- where R is an alkyl, arylalkyl, cycloalkyl, aromatic or heterocyclic group, and N
15 is 1, 2, or 3 and named by prefixing the parent acid with peroxy.

- The peracid normally exists in an equilibrium state with the original or fundamental acid and the peroxide source, usually hydrogen peroxide. Typical peracids include peracids of C_1 to C_{12} carboxylic acids such as formic acid,
20 acetic acid, propanoic acid, butanoic acid, pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, and the like. The term carboxylic acids as used in the practice of the present invention, unless otherwise limited, also includes mono- and di-hydroxycarboxylic acids such as glycolic acid, lactic acid and citric acid. An
25 example of di-hydroxycarboxylic acid or di-hydroxy is tartaric acid, and also fumaric acid, which is an unsaturated di-hydroxycarboxylic acid. Diacids such as alpha-omega-dicarboxylicpropanoic acid, succinic acid, glutaric acid, adipic acid, and the like may also be used to form di-peracids. Peroxycarboxylic acids may also be present and included within the solutions of the present invention.
30 Mixtures and combinations of the peracids may also be used in the systems of the invention, as well as other addenda as generally described herein.

The peroxide source is preferably an aqueous solution of hydrogen peroxide, but may also include such alternative peroxide sources as solutions of sodium peroxide, calcium peroxide, alkali salts of percarbonate and persulfate, and even organic peroxides such as dicumyl peroxide, dialkyl peroxides, urea
5 peroxide, and the like, forming the basis of the solution of the hydrogen peroxide. The inorganic peroxides are preferred as the source of the solution of the hydrogen peroxide. The ratio of the peroxy acid to the hydrogen peroxide can also significantly influence the efficacy of the solutions of the invention, with higher ratios of the peroxy acid to the hydrogen peroxide preferred. For
10 example, it is more desirable to have a ratio of at least 2:1 or 3:1 (peroxy acid to hydrogen peroxide), and more desirable to have higher ratios of at least 4:1, at least 5:1 or at least 8:1 or more (peroxy acid to hydrogen peroxide).

The buffering agent is a compound, again preferably an inorganic compound which will maintain a buffered pH level in the solution of the
15 composition between 5.0 and 7.0. Buffering agents include, but are not limited to phosphates, borates, lactates, acetates, citrates, vanadates, tungstates, and combinations thereof, particularly alkali metal or alkaline metal salts of these agents. The use of phosphates exclusively or at least primarily (e.g., at least 50%, at least 65%, at least 75%, or at least 90 or 95% by weight of the buffering
20 agents) is particularly useful. Trisodium phosphate has been found to be particularly desirable because of its ability to maintain the acid residues of the peroxy acids in solution where they will not form film in the solution which can be picked up by any sterilization apparatus or medical device which is being sterilized. It is interesting to note that phosphates have been generally taught to
25 be avoided in sterilization solutions where hard water may be contacted because of the potential for calcium precipitation, yet in the present invention, the presence of phosphates reduces the formation of organic residue film on the surface of the solution. The buffering agent alone, even when a phosphate or especially when a phosphate and particularly trisodium phosphate, has been
30 found to reduce corrosion by the solution on all surfaces. The use of phosphate(s) alone, in the absence of copper and brass corrosion inhibitors has been found to be an effective sterilant, and provide non-corrosive activity against a wide range of structural materials, including, but not limited to rubbers,

plastics and metals, such as stainless steel, aluminum, polypropylene, teflon, acrylonitrile/styrene/butadiene, polyolefins, vinyl resins (e.g., polyvinyl chloride, polyvinylbutyral), silicone resins and rubbers, and polyurethanes, and provide second tier protection for brass and copper. Although the peracids work more
5 efficiently in their microbiocidal activity at highly acidic pH levels (below 4.0), those acidic levels are much more corrosive. The use of a buffering system which maintains the pH above 5.0 and preferably between about 5.0 and 7.0 still provides a microbiocidal activity at levels which meet all international standards, using anywhere from 150 to 10,000 parts per million peracid.

10 The sterilant can be used as a manual system or be used in an automated system. The sterilant can be provided as a one-part or preferably two part concentrate, with the peracid in one solution and the buffer in the second solution. For example, in a two-part system, a peracid concentrate may be formed having .01% to 1% by weight peracid (e.g., peracetic acid), .003% to 1%
15 by weight ppm hydrogen peroxide, .01% to 1% by weight acid (e.g., acetic acid), and the buffer solution may comprise, for example, from 0.5 to 75,000 ppm buffering agent (e.g., anhydrous trisodium phosphate) in water. Mixtures of these types of addenda, including the buffering agents and peracids, are clearly useful in the practice of the present invention. It is preferred that the
20 concentrates have active ingredient contents at the higher levels of these ranges such as .1% to 15% by weight peracid, 5% to 80% by weight peroxide, 5% to 80% by weight acid and .1% to 15% by weight buffering agents. The diluted to use solution would preferably contain sufficient actives to provide .01% to 1.0% by weight peracid at a pH between about 5.0 and 7.0. The use solution need not
25 contain any effective amount of many of the additives which prior art systems have required for non-corrosive effects (such as the organic anti-corrosive agents such as the triazines, benzotriazoles, azoles and benzoates), and yet provide a wider disclosed range of non-corrosivity against the many available surfaces of medical devices. The use solutions of the present invention may comprise a
30 simplest solution comprising peracid (along with the acid and peroxide in equilibrium), buffering agent in an amount to provide a pH of from about 5.0 to 7.0, and water (preferably deionized water). This solution may be modified by the addition of individual agents such as chelating agents, surfactants (also

referred to in the literature for sterilant compositions as wetting agents), and anti-corrosion agents. A typical concentrate solution which may be diluted to a use solution might comprise, 0.1% to 15% by weight peracid, 0.1% to 15% by weight buffering agent, with the remainder as water and other addenda as generally described herein (e.g., from 99.6 to 78% by weight water). These and other aspects of the invention will be further described by reference to the following, non-limiting examples.

These data show that a preferred range for the concentration of peroxide in the solution (particularly as evidenced by hydrogen peroxide) less than 150 ppm, preferably less than 100 up to 80,000 ppm, still more preferably less than 100, less than 75 and less than 50 ppm. In the examples, POAA represents peroxyacetic acid, AA represents acetic acid, POOA represents peroxyoctanoic acid, and Oct. Acid represents octanoic acid. DequestTM are commercially available materials which may be used in the solutions of the present invention. DequestTM 2000 comprises aminotri(methylene-phosphonic acid), DequestTM 2010 comprises 1-hydroxyethylidene-1,1-diphosphonic acid, and DequestTM 2006 comprises aminotri(methylene-phosphonic acid) pentasodium salt. Dequest acts as a chelator for heavy metals. The data also shows that sporicidal activity of compositions with higher molecular weight peracids increase with higher proportions of the peracid as compared to the acid.

The presence of a catalyst for the formation of the peracid in the sterilization compositions of the present invention also is a novel aspect of the present invention which could act to maintain the level of peracid in the solution during use.

Corrosion Example I

Experimental

In the following comparison example, a formulation according to the present invention comprising 2.69 weight percent of a 13% solution of peracetic acid made by combining 78% glacial acetic acid, 21% hydrogen peroxide (35% by weight in water), and 1% hydroxyethylenediamine phosphonate was compared to a commercial sterilization formulation (CSF) comprising a mixture of sodium perborate and tetraacetyl ethylenediamine with a buffer to provide a use solution of pH 8, with its necessary sterilization activator. The CSF

composition (referred to as Powder PAA) comprises a powder source of peracetic acid (with a solid peroxide source) without a buffering agent, and was compared to a liquid solution of peracetic acid (PAA) made according to the present invention (referred to as Liquid PAA) by admixture of acetic acid and

5 hydrogen peroxide solution with 1% by weight of hydroxyethylenediamine phosphonate catalyst to form the solution of peracetic acid (with the equilibrium amounts of acetic acid and hydrogen peroxide) at a pH of 6.0 provided by 3.0% by weight trisodium phosphate. This commercial CSF product requires mixing of a dry powder, with a delay required for the activator TAED (tetra acetyl

10 ethylene diamine) by reaction with sodium perborate to generate peracetic acid and microbiocidal activity in the components.

Test Parameters:

The test was performed on pieces of an Olympus flexible endoscopes

15 using a washer/disinfector to reduce manual variables. The test parameters were room temperature conditions, with the following immersion times:

	Sample	Cycles	Immersion Time
	Liquid PAA	1	10 minutes
20	Powder PAA	1	15 minutes

Sample	Application Time
Liquid PAA	24 hours
Powder PAA	8 hours

25 The test was performed by completely **immersing** separate test pieces S1 to S7 and W1 to W28 in each of the solutions.

Test Pieces

	Item	Parts
30	S1 - S7	Parts of endoscope
	S8 and S9	Insertion tube
	S10	Light guide tube
	W1 - W28	Parats of washer/disinfector

	Sample No.	Material (base)	Surface Control	Place of the Parts
	S1	A5056BD-H32 Resin	black painting	connector to LS
	S2	Polysulfone	black painting	main body
	S3	SUS304 Resin	El. black coating	outside (hidden)
5	S4	Silicone Rubber	—	outside
	S5	Polybutadiene PB-60	—	outside
	S6	Mod. PPO Polyphenyleneoxide	black painting	main body
	S7	A5056BD-H32 Resin	black alumite	eyepiece
	S	Polyurethane	primary coat Z	insertion tube
10	S	Polyurethane	primary coat V	insertion tube
	S	Polyurethane		light guide cable
	W1	Stainless Steel		inner pipe system
	W2	Stainless Steel		inner pipe system
	W3	epoxy resin+coating		heating panel
15	W4	Polyethylene		basin
	W5	Polypropylene		basin
	W6	Polyacetate		connector
	W7	Polysulfone		part of top cover
	W8	Silicone Rubber		sealing
20	W9	Polyvinyl chloride		inner pipe system
	W10	Polyvinyl chloride (hard)		inner pipe system
	W11	Acrylic polymer		parts in the basin
	W12	Ethylene/propylene		inner pipe system
	W13	Ethylene/propylene rubber		inner pipe system
25	W14	Acrylate modified PolyVinylChloride		top cover
	W15	Butyl-nitrile rubber + Phenol		parts in the basin
	W16	Teflon		name plate in basin
	W17	Butyl-nitrile rubber		sealing

5	W18	Polyurethane		?
	W19	Acrylonitrile/butadiene/ styrene		top cover
	W20	modified PPO		top cover
	W21	Butyl rubber		sealing
	W22	fluorinated rubber		sealing
	W23	alumina ceramic		parts of pump system
	W24	Teflon		parts of pump system
	W24	Teflon rubber		parts of pump system

10 **Conclusion**

The samples were carefully inspected to evaluate the cosmetic effects (corrosion effects) on the various pieces. The first examination (Item 1) was for parts of the endoscope. The second examination (Item 2) was for the insertion tube. The third examination (Item 3) was for the light guide tube. The fourth examination (Item 4) was for the washer/disinfector. The samples performed substantially identically, with both solutions showing only a slight cosmetic change in painted black surface of the endoscope (S3 surface). No functional or cosmetic changes were noted on any other sample. The simplicity of use for the Liquid PAA system was very noteworthy, with no delay in mixing or reaction time. The solutions could be directly added into an automated system while the CSF Powder PAA system would have required premixing and activation time before it could have been used in an automatic system.

Corrosion Example II

25 **Experimental**

A corrosion study was performed to evaluate peracid containing formulas with and without buffer addition upon selected metals, plastics and rubbers.

Testing was conducted with two peracid formulations of 500 ppm (parts per million) peracetic acid (A) and 5000 ppm peracetic acid (B) concentration without buffer; and, two identical formulas (C and D respectively) with exception of buffer addition admixture.

- 5 Coupons were completely immersed in 200 mls of defined test solution contained in covered 8 ounce glass jars maintained at 50°C within an environmental chamber. Solutions were changed daily. Study was conducted over a 14 day time period. For each test material, a control was also run which is a coupon of stated material placed within a covered 8 ounce glass jar having no
10 test solution.

- Coupons were pretreated before the corrosion study began, and posttreated before final comparative measurements and visual observations were performed. Metal coupons were precleaned according to ASTM Vol. 3.02, G31-72 and 3.02, G1-90 protocol and post-treated accordingly prior to final
15 measurement. Test conditions were modified from the ASTM protocol as explained in above paragraph. Plastic and rubber coupons were only rinsed with deionized water and air dried prior to corrosion study; and, similarly treated prior to final measurement and visual observation.

20 **Conclusion**

Addition of buffer admixture to peracetic acid composition test solutions significantly improves metals protection. The effect is less noticeable on test plastics; but, protection is provided selected test rubbers.

PART IA: FORMULA - PERACID COMPONENT

HIGH POAA - LOW H2O2 PERACID FORMULA KX-6091

			GM/
			10000
ITEM	RAW MATERIAL	WT%	
5	10 Acetic Acid	78.00	7800.00
	20 Hydrogen Peroxide	21.00	2100.00
	35%		
	30 Dequest™ 2010 (60%)	1.00	100.00
	Total	100.00	10000.00

10

Mixing Instructions:

Batch was prepared by direct weighing on Mettler PM 16 Top Loading Balance into a 5 gal HMW/HDPE (high molecular weight/high density polypropylene) pail. The batch was mixed for 65 minutes using a lab mixer equipped with a

15 plastic coated stir rod and blade.

PART IB: FORMULA - ADMIXTURE OF IA
AND BUFFER COMPONENT
FORMULAS A, B, C, D
CORROSION STUDY USE DILUTIONS

ITEM	Material	(A)		(B)		(C)		(D)	
		WT%	GM/ 4500	WT%	GM/ 4500	WT%	GM/ 4500	WT%	GM/ 4500
10	Deionized Water	99.10556	4459.75	90.66311	4079.84	99.55756	4480.09	95.57511	4300.88
20	Trisodium Phosphate Anhyd. Gran.	0.45200	20.41	4.91200	221.04				
30	KX-6091 (11.3% POAA)	0.44244	19.91	4.42489	199.12	0.44244	19.91	4.42489	199.12
Total		100.00000	4500.07	100.00000	4500.00	100.00000	4500.00	100.00000	4500.00
THEORETICAL VALUES		ppm	pH	ppm	pH	ppm	pH	ppm	pH
POAA		500	6.00	5000	6.00	500	3.00	5000	2.50

14

INSTRUCTIONS

Add Trisodium Phosphate Anhydrous Granules (item 20) by wt. to weighed amount of DI water and stir with Lab mixer until dissolved. Add (item 30) by wt. to buffered water and final mix 2 min.

RESULTS:

- (A) - pH = 6.02
(B) - pH = 5.99
(C) - pH = 2.96
(D) - pH = 2.35

PART II: CORROSION - METALS

14 day Compatibility Test of 15 different materials tested against four different Test Solutions at 50°C with the test solutions are changed daily.

Test item	Test Solution	Material METALS	Initial Wt. (gms)	Final Wt. (gms)	TWL	CWL	AWL mpy
1	(A) 500 ppm POAA/Buffered	316 SS	23.5792	23.5791	0.0001	0.0001	0.0000
5	(B) 5000 ppm POAA/Buffered	316 SS	23.5194	23.5193	0.0001	0.0001	0.0000
9	(C) 500 ppm POAA only	316 SS	23.5764	23.5762	0.0002	0.0001	0.0031
13	(D) 5000 ppm POAA only	316 SS	23.5690	23.5689	0.0001	0.0001	0.0000
17	CONTROL	316 SS	23.5846	23.5845	0.0001	0.0001	
2	(A) 500 ppm POAA/Buffered	304 SS	17.9651	17.9650	0.0001	0.0000	0.0031
6	(B) 5000 ppm POAA/Buffered	304 SS	17.9326	17.9323	0.0003	0.0000	0.0938
10	(C) 500 ppm POAA only	304 SS	17.9795	17.9793	0.0002	0.0000	0.0063
14	(D) 5000 ppm POAA only	304 SS	17.9993	17.9992	0.0001	0.0000	0.0031
18	CONTROL	304 SS	18.1102	18.1102	0.0000	0.0000	
3	(A) 500 ppm POAA/Buffered	7075 Aluminum	12.8716	12.8685	0.0031	0.0002	0.2412
7	(B) 5000 ppm POAA/Buffered	7075 Aluminum	12.7575	12.7336	0.0239	0.0002	0.0237
11	(C) 500 ppm POAA only	7075 Aluminum	12.8651	12.8392	0.0259	0.0002	0.0257
15	(D) 5000 ppm POAA only	7075 Aluminum	12.8718	12.7439	0.1279	0.0002	0.1277
19	CONTROL	7075 Aluminum	12.4899	12.4897	0.0002	0.0002	
4	(A) 500 ppm POAA/Buffered	260 Brass	26.4108	26.3763	0.0345	0.0004	0.0341
8	(B) 5000 ppm POAA/Buffered	260 Brass	26.4211	26.3307	0.0904	0.0004	0.0900
12	(C) 500 ppm POAA only	260 Brass	26.6471	25.6695	0.9776	0.0004	0.9772
16	(D) 5000 ppm POAA only	260 Brass	26.4949	18.9759	7.5190	0.0004	7.5186
20	CONTROL	260 Brass	26.4352	26.4348	0.0004	0.0004	215.6118

PART II: CORROSION - METALS - OBSERVATIONS

Test item	Test Solution	Material	Visual Observations
		METALS	
1	(A) 500 ppm POAA/Buffered	316 SS	Smooth, shiny silver colored material like control
5	(B) 5000 ppm POAA/Buffered	316 SS	Smooth, shiny silver colored material like control
9	(C) 500 ppm POAA only	316 SS	Smooth, shiny silver colored material like control
13	(D) 5000 ppm POAA only	316 SS	Smooth, shiny silver colored material like control
17	CONTROL	316 SS	Smooth, shiny silver colored material
2	(A) 500 ppm POAA/Buffered	304 SS	Smooth, shiny silver colored material like control
6	(B) 5000 ppm POAA/Buffered	304 SS	Smooth, shiny silver colored material like control
10	(C) 500 ppm POAA only	304 SS	Smooth, shiny silver colored material like control
14	(D) 5000 ppm POAA only	304 SS	Smooth, shiny silver colored material like control
18	CONTROL	304 SS	Smooth, shiny silver colored material
3	(A) 500 ppm POAA/Buffered	7075 Aluminum	A slt. duller, slt. whiter than control, silver material
7	(B) 5000 ppm POAA/Buffered	7075 Aluminum	A very dull, smokey brown colored material
11	(C) 500 ppm POAA only	7075 Aluminum	A dull, whitish gray colored material
15	(D) 5000 ppm POAA only	7075 Aluminum	A very dull, very whitish gray colored material
19	CONTROL	7075 Aluminum	A slt. dull, silver colored material
4	(A) 500 ppm POAA/Buffered	260 Brass	A mixture of dull gold & pink area colored material
8	(B) 5000 ppm POAA/Buffered	260 Brass	A dull, gold colored material with patches of pink
12	(C) 500 ppm POAA only	260 Brass	A darker dull gold colored material with pink areas
16	(D) 5000 ppm POAA only	260 Brass	A sparkling grainy gold colored material
20	CONTROL	260 Brass	A smooth, shiny, gold colored material

KX-6091 CORROSION STUDY

CALCULATION DATA

<u>4 Metals</u>	<u>DENSITY</u>	<u>AREA in inches squared</u>
316 Stainless Steel	7.98	6.5
304 Stainless Steel;	7.94	6.4
7075 Aluminum	2.81	6.8
260 Brass	8.5	6.52

Time & Temp Tested
14 days at 50°C

$$\text{mpy} = (534,000 * \text{AWL}) / (\text{A} * \text{T} * \text{D})$$

(A) = Area (see above)
(T) = Time (336 hrs)
(D) = Density (see above)

AWL = TWL - CWL

TWL = Pre-testing weight - Post-testing weight

CWL = Pre-testing weight of control - Post-testing weight of control

mpy = mils per year

PART III: CORROSION - PLASTICS
Analytical - Observations

KX-6091 CORROSION STUDY

14 day Compatibility Test of 15 different materials tested against four different Test Solutions at 50°C with the test solutions are changed daily.

Test Item	Test Solution	Material	Initial Wt. (gms)	Initial Ht. (inches)	Initial Width (inches)	Initial Thick (inches)	Final Wt. (gms)	% Weight Change	Final Ht. (inches)	% Height Change	Final Width (inches)	% Width Change	Final Thick (inches)	% Thick Change
21	(A) 500 ppm POAA/Buffered	Polyurethane	3.8348	2.996	0.506	0.128	3.8360	0.0313	2.996	0.0000	0.507	0.1976	0.128	0.0000
27	(B) 5000 ppm POAA/Buffered	Polyurethane	3.8379	2.996	0.502	0.129	3.8385	0.0156	2.998	0.0668	0.502	0.0000	0.128	-0.7752
33	(C) 500 ppm POAA only	Polyurethane	3.8385	2.999	0.505	0.128	3.8418	0.0860	3.004	0.1567	0.505	-0.1976	0.127	-0.7813
39	(D) 5000 ppm POAA only	Polyurethane	3.8151	2.995	0.504	0.127	3.7411	-1.9397	3.061	2.2037	0.509	0.9921	0.125	-1.5748
45	CONTROL	Polyurethane	3.8286	2.996	0.505	0.128	3.8200	-0.2248	2.993	-0.1001	0.504	-0.1980	0.128	0.0000
22	(A) 500 ppm POAA/Buffered	Polyethylene	1.3741	2.991	0.505	0.066	1.3736	-0.0364	2.991	0.0000	0.504	-0.1980	0.066	0.0000
28	(B) 5000 ppm POAA/Buffered	Polyethylene	1.3676	2.991	0.505	0.064	1.3675	-0.0073	2.991	0.0000	0.505	0.0000	0.065	1.5625
34	(C) 500 ppm POAA only	Polyethylene	1.3541	2.992	0.504	0.065	1.3541	0.0000	2.991	-0.0334	0.502	-0.3968	0.065	0.0000
40	(D) 5000 ppm POAA only	Polyethylene	1.3586	2.995	0.504	0.066	1.3593	0.0515	2.994	-0.0334	0.502	-0.3968	0.066	0.0000
46	CONTROL	Polyethylene	1.3668	2.991	0.504	0.068	1.3667	-0.0073	2.989	-0.0669	0.504	0.0000	0.068	0.0000
23	(A) 500 ppm POAA/Buffered	Polypropylene	1.3792	3.002	0.504	0.066	1.3792	0.0000	3.001	-0.0333	0.503	-0.1984	0.067	1.5152
29	(B) 5000 ppm POAA/Buffered	Polypropylene	1.3774	2.998	0.503	0.065	1.3775	0.0073	2.999	0.0334	0.503	0.0000	0.066	1.5385
35	(C) 500 ppm POAA only	Polypropylene	1.3793	2.998	0.504	0.065	1.3796	0.0218	2.998	0.0000	0.503	-0.1984	0.065	0.0000

Test Solution item	Material PLASTICS	Initial Wt. (gms)	Initial Ht. (inches)	Initial Width (inches)	Initial Thick (inches)	Final Wt. (gms)	% Weight Change	Final Ht. (inches)	% Height Change	Final Width (inches)	0.0000	0.065	0.0000
47 CONTROL	Polypropylene	1.3812	2.997	0.503	0.065	1.3811	-0.0072	2.997	0.0000	0.503	0.0000	0.065	0.0000
24 (A) 500 ppm POAA/Buffered	Polyvinyl Chloride	2.1801	3.002	0.505	0.066	2.1843	0.1927	3.002	0.0000	0.506	0.1980	0.065	-1.5152
30 (B) 5000 ppm POAA/Buffered	Polyvinyl Chloride	2.2005	2.997	0.505	0.066	2.2041	0.1636	2.997	0.0000	0.506	0.1980	0.066	0.0000
36 (C) 500 ppm POAA only	Polyvinyl Chloride	2.1734	2.998	0.505	0.065	2.1777	0.1978	2.998	0.0000	0.505	0.0000	0.065	0.0000
42 (D) 5000 ppm POAA only	Polyvinyl Chloride	2.1590	2.998	0.505	0.065	2.1625	0.1621	2.997	-0.0334	0.505	0.0000	0.065	0.0000
48 CONTROL	Polyvinyl Chloride	2.2048	2.999	0.505	0.056	2.2037	-0.0499	2.998	-0.0333	0.505	0.0000	0.056	0.0000
25 (A) 500 ppm POAA/Buffered	ABS	1.4724	2.995	0.507	0.061	1.4762	0.2581	2.999	0.1336	0.508	0.1972	0.061	0.0000
31 (B) 5000 ppm POAA/Buffered	ABS	1.5167	3.003	0.507	0.063	1.5201	0.2242	3.006	0.0999	0.506	-0.1972	0.063	0.0000
37 (C) 500 ppm POAA only	ABS	1.5082	3.000	0.507	0.062	1.5132	0.3315	3.004	0.1333	0.508	0.1972	0.062	0.0000
43 (D) 5000 ppm POAA only	ABS	1.4971	2.995	0.505	0.062	1.5047	0.5076	3.000	0.1669	0.510	0.9901	0.062	0.0000
49 CONTROL	ABS	1.4822	2.995	0.507	0.062	1.4813	-0.0607	2.995	0.0000	0.508	0.1972	0.062	0.0000
26 (A) 500 ppm POAA/Buffered	Polyacetal	4.4596	3.003	0.507	0.133	4.5033	0.9799	3.010	0.2331	0.508	0.1972	0.134	0.7519
32 (B) 5000 ppm POAA/Buffered	Polyacetal	4.3970	3.003	0.507	0.131	4.4302	0.7551	3.009	0.1998	0.507	0.0000	0.132	0.7634
38 (C) 500 ppm POAA only	Polyacetal	4.4967	3.004	0.506	0.134	4.5441	1.0092	3.014	0.3329	0.508	0.3953	0.135	0.7463
44 (D) 5000 ppm POAA only	Polyacetal	4.3832	3.003	0.507	0.131	4.4264	0.9856	3.012	0.2997	0.508	0.1972	0.132	0.7634
50 CONTROL	Polyacetal	4.4498	3.002	0.506	0.133	4.4454	-0.0989	3.000	-0.0666	0.506	0.0000	0.133	0.0000

Test item	Test Solution	Material	Visual Observations
		PLASTICS	
21	(A) 500 ppm POAA/Buffered	Polyurethane	Dull opaque orange material with semi-transparent boarder
27	(B) 5000 ppm POAA/Buffered	Polyurethane	Dull opaque orange material with semi-transparent boarder and slt. tacky
33	(C) 500 ppm POAA only	Polyurethane	Dull darker opaque orange material with semi-transparent boarder and slt. tacky
39	(D) 5000 ppm POAA only	Polyurethane	Very dark orange, very tacky, completely opaque material that stuck to drying surface resulting in loss of material
45	CONTROL	Polyurethane	A dull, dirty, slt. yellow tinted, semi-transparent material
22	(A) 500 ppm POAA/Buffered	Polyethylene	Slt. whiter material than control
28	(B) 5000 ppm POAA/Buffered	Polyethylene	Slt. whiter material than control
34	(C) 500 ppm POAA only	Polyethylene	Slt. whiter material than control
40	(D) 5000 ppm POAA only	Polyethylene	Slt. whiter material than control
46	CONTROL	Polyethylene	A dull, grayish white material
23	(A) 500 ppm POAA/Buffered	Polypropylene	A white filmy, faintly transparent, more cloudy material than control
29	(B) 5000 ppm POAA/Buffered	Polypropylene	A white filmy, faintly transparent, more cloudy material than control
35	(C) 500 ppm POAA only	Polypropylene	A white heavy filmed, faintly transparent, more cloudy material than control
41	(D) 5000 ppm POAA only	Polypropylene	A white filmy, faintly transparent, more cloudy material than control
47	CONTROL	Polypropylene	A dull gray, semi-transparent material
24	(A) 500 ppm POAA/Buffered	Polyvinyl Chloride	Slt. less shiny and slt. less dark gray material than control

Test item	Test Solution	Material	Visual Observations
		PLASTICS	
36	(C) 500 ppm POAA only	Polyvinyl Chloride	A dull med. gray material
42	(D) 5000 ppm POAA only	Polyvinyl Chloride	A dull light to medium gray material
48	CONTROL	Polyvinyl Chloride	A dark, shiny gray material
25	(A) 500 ppm POAA/Buffered	ABS	A slt. dull, whiter material than control
31	(B) 5000 ppm POAA/Buffered	ABS	A slt. dull, whiter material than control
37	(C) 500 ppm POAA only	ABS	A slt. dull, much whiter white material than control
43	(D) 5000 ppm POAA only	ABS	A slt. dull bright white material
49	CONTROL	ABS	A slt. dull, vanilla white material
26	(A) 500 ppm POAA/Buffered	Polyacetal	A dull, cleaner white appearance than control
32	(B) 5000 ppm POAA/Buffered	Polyacetal	A dull, cleaner white appearance than control
38	(C) 500 ppm POAA only	Polyacetal	A dull, cleaner white appearance than control
44	(D) 5000 ppm POAA only	Polyacetal	A dull, cleaner white appearance than control
50	CONTROL	Polyacetal	A dull, dirty white material

PART IV: CORROSION - RUBBERS

Analytical - Observations

KX-6091 CORROSION STUDY

14 day Compatibility Test of 15 different materials tested against four different Test Solutions at 50°C with the test solutions are changed daily.

Test Item	Test Solution	Material	Initial WL (gms)	Initial Ht (inches)	Initial Width (inches)	Initial thick (inches)	Final WL (gms)	% Weight Change	Final Ht (inches)	% Height Change	Final Width (inches)	% Width Change	Final Thick (inches)	% Thick Change
51	(A) 500 ppm POAA/Buffered	Silicone	14.2724	2.930	0.928	0.254	14.2553	-0.1198	2.930	0.0000	0.933	0.5388	0.254	0.0000
56	(B) 5000 ppm POAA/Buffered	Silicone	15.5707	2.999	1.007	0.249	15.5665	-0.0270	2.995	-0.1334	1.008	0.0993	0.249	0.0000
61	(C) 500 ppm POAA only	Silicone	15.6958	3.013	0.995	0.252	15.7755	0.5078	3.019	0.1991	1.004	0.9045	0.252	0.0000
66	(D) 5000 ppm POAA/Silicone only	Silicone	15.1443	2.977	0.994	0.246	15.3760	1.5299	3.003	0.6734	1.005	1.1066	0.249	1.2195
71	CONTROL	Silicone	15.6702	2.970	1.001	0.253	15.6417	-0.1819	2.970	0.0000	1.013	1.1988	0.254	0.3953
52	(A) 500 ppm POAA/Buffered	Butyl	1.9074	2.999	0.507	0.069	1.9852	4.0789	3.008	0.3001	0.507	0.0000	0.071	2.8986
57	(B) 5000 ppm POAA/Buffered	Butyl	1.9082	2.999	0.505	0.069	1.9263	0.9485	3.008	0.3001	0.505	0.0000	0.069	0.0000
62	(C) 500 ppm POAA only	Butyl	1.9026	2.996	0.505	0.068	2.0729	8.9509	3.017	0.7009	0.513	1.5842	0.075	10.2941
67	(D) 5000 ppm POAA/Butyl only	Butyl	1.9097	2.998	0.507	0.069	2.2216	16.3324	3.029	1.0340	0.494	-2.5841	0.078	13.0435
72	CONTROL	Butyl	1.9001	2.998	0.507	0.069	1.8939	-0.3263	2.998	-0.0867	0.504	-0.5917	0.069	0.0000
53	(A) 500 ppm POAA/Buffered	Vison	23.3725	3.057	1.031	0.248	23.4407	0.2918	3.071	0.4580	1.033	0.1940	0.248	0.0000
58	(B) 5000 ppm POAA/Buffered	Vison	21.3847	2.984	1.014	0.237	21.4843	0.5598	2.998	0.4692	1.025	1.0848	0.238	0.4219

Test Item	Test Solution	Material	Initial Wt (gms)	Initial Ht (inches)	Initial Width (inches)	Initial Thick (inches)	Final Wt (gms)	Final Ht (inches)	% Height Change	Final Width (inches)	% Width Change	Final Thick (inches)	% Thick Change
68	(D) 5000 ppm POAA/Vison only	RUBBERS	22.4157	2.964	1.012	0.251	23.7728	3.064	3.3738	1.053	4.0514	0.260	3.5857
73	CONTROL	Vison	22.0694	2.988	1.012	0.244	22.0584	2.991	0.1004	1.012	0.0000	0.244	0.0000
54	(A) 500 ppm POAA/Buffered	EPDM	17.0399	3.042	1.005	0.277	17.1763	3.053	0.3616	1.009	0.3980	0.285	2.8881
59	(B) 5000 ppm POAA/Buffered	EPDM	16.9577	3.033	1.006	0.278	17.2265	3.036	0.0989	1.012	0.5964	0.285	2.5180
64	(C) 500 ppm POAA only	EPDM	16.9824	3.059	1.015	0.275	16.9653	3.068	0.2942	1.012	-0.2956	0.282	2.5455
69	(D) 5000 ppm POAA only	EPDM	17.4875	2.985	1.072	0.274	17.9757	3.020	1.1725	1.079	0.6530	0.284	3.6496
74	CONTROL	EPDM	16.7254	2.964	1.016	0.278	16.6918	2.959	-0.1687	1.015	-0.0984	0.278	0.0000
55	(A) 500 ppm POAA/Buffered	BUNA N	15.8678	2.960	1.006	0.242	16.3169	2.970	0.3378	1.012	0.5964	0.247	2.0661
80	(B) 5000 ppm POAA/Buffered	BUNA N	15.9576	2.980	1.020	0.240	16.4275	2.989	0.3020	1.019	-0.0980	0.246	2.5000
85	(C) 500 ppm POAA only	BUNA N	16.2737	2.977	1.016	0.246	18.9478	2.992	0.5039	1.024	0.7874	0.259	5.2846
70	(D) 5000 ppm POAA only	BUNA N	15.8516	2.956	1.014	0.242	16.5043	2.956	0.0000	1.029	1.4793	0.264	9.0909
75	CONTROL	BUNA N	16.0735	2.936	1.107	0.247	16.0328	2.937	0.0341	1.014	-0.2950	0.247	0.0000

Test item	Test Solution	Material	Visual Observations
		RUBBERS	
51	(A) 500 ppm POAA/Buffered	Silicone	A dull, med. - dark orange material similar to control
56	(B) 5000 ppm POAA/Buffered	Silicone	A dull, med. - dark orange material similar to control
61	(C) 500 ppm POAA only	Silicone	A dull, med. - dark orange material similar to control
66	(D) 5000 ppm POAA only	Silicone	A dull, med. - dark orange material similar to control
71	CONTROL	Silicone	A dull, med. - dark orange material
52	(A) 500 ppm POAA/Buffered	Butyl	A dull black material with slt. tacky, slt. rough surface that stuck to drying surface resulting in loss of material
57	(B) 5000 ppm POAA/Buffered	Butyl	A dull black material with very slt. tacky, smooth surface
62	(C) 500 ppm POAA only	Butyl	A black material with tacky, dull, rough surface that stuck to drying surface resulting in loss of material
67	(D) 5000 ppm POAA only	Butyl	A dull black material with very tacky, very rough, surface that stuck to drying surface resulting in loss of material

Test item	Test Solution	Material RUBBERS	Visual Observations
53	(A) 500 ppm POAA/Buffered	Vison	A dull, charcoal black material with smooth surface
58	(B) 5000 ppm POAA/Buffered	Vison	A dull, charcoal black material with smooth surface
63	(C) 500 ppm POAA only	Vison	A dull, charcoal black material with slt. rough surface
68	(D) 5000 ppm POAA only	Vison	A dull, charcoal black material with slt. rough surface
73	CONTROL	Vison	A dull, charcoal black material with smooth surface
54	(A) 500 ppm POAA/Buffered	EPDM	A dull, black material with slt. rough surface
59	(B) 5000 ppm POAA/Buffered	EPDM	A dull, black material with slt. blistered surface
64	(C) 500 ppm POAA only	EPDM	A dull, black material with slt. rough surface
69	(D) 5000 ppm POAA only	EPDM	A dull black material with slt. rough surface containing a large blister
74	CONTROL	EPDM	A dull, black material with smooth surface
55	(A) 500 ppm POAA/Buffered	BUNA N	A dull, (darker than control) black material with slt. rough surface
60	(B) 5000 ppm POAA/Buffered	BUNA N	A dark black material with very slt. shiny, fairly smooth surface
65	(C) 500 ppm POAA only	BUNA N	A dark black material with very slt. shiny, slt. blistered surface
70	(D) 5000 ppm POAA only	BUNA N	A dark black material with very slt. shiny, blistered surface
75	CONTROL	BUNA N	A dull, grayish black material with smooth surface

I. Tuberculocidal Efficacy US Method 26

The peracetic acid product was tested against *Mycobacterium bovis* (BCG) using the AOAC Confirmatory Test with product concentrations as listed below. The product was diluted in buffer to achieve the pH 6 prior to test. The diluent tested was either tap or distilled water. Test exposure time was 10 minutes. A result of ten no growth tubes per ten tubes tested is required for a passing result. Conclusion: successful tuberculocidal results were achieved at product concentrations as low as 1000 ppm POAA.

Product Concentration ^a	Number of no growth tubes / number of tubes tested ^b
1000 ppm POAA	10/10 - pass
2000 ppm POAA	10/10 - pass
3000 ppm POAA	10/10 - pass
4000 ppm POAA	10/10 - pass
5000 ppm POAA	10/10 - pass

^aDiluent was tap or distilled water with pH adjusted to 6.

^bTest results reflect data achieved in three test media, Proskauer-Beck, Kirshners and Middlebrook.

II. Suspension Test - Olympus Method

We have completed the suspension test as requested with the Olympus procedure versus *Bacillus subtilis*. The product was diluted in buffer to achieve the pH 6 prior to test. The diluent tested was tap water. Test exposure times are listed below. The data are represented as log reduction of bacterial numbers. Note: the spores were counted after the heat shock treatment, although the test was conducted on a non-heat treated bacterial suspension. Conclusion significant log reductions in microbial numbers were achieved within 10 minutes using 500 ppm

POAA. Additional product concentration or exposure time did not increase the efficacy of the product.

Exposure time (minutes)	<i>Bacillus subtilis</i> Log Reduction at 20°C (ppm POAA)				
	250 ppm	500 ppm	1000 ppm	1500 ppm (Henkel-Ecolab test only)	2000 ppm (Ecolab test only)
5 minutes	4.55	6.13	9.48	7.70	9.78
10 minutes	7.98	9.78	9.78	7.68	9.78
20 minutes	9.48	9.78	9.78	7.71	9.78
60 minutes	9.48	9.78	9.78	7.74	9.78
Neutralization control					0.10 ^a
Total inoculum				3.4 x 10 ⁶ cfu/ml	6.0 x 10 ⁹ cfu/ml
Spore inoculum				9.0 x 10 ⁶ cfu/ml	3.3 x 10 ⁵ cfu/ml

^a Neutralizer is 1% sodium thiosulfate and is effective in this test procedure for chemical neutralization of the test substance.

III. Carrier Test - Olympus Method

We have completed the carrier test as requested using the Olympus procedure versus *Bacillus subtilis* and *Mycobacterium terrae*. The product was diluted in buffer to achieve the pH 6 prior to test. The diluent tested was tap water. Test exposure times are listed below. Note: the spores were counted after the heat shock treatment, although the test was conducted on a non-heat treated bacterial suspensions. Conclusion: successful results achieved using 250 ppm POAA within five minutes exposure against both *subtilis* and *Mycobacterium terrae*. Additional product concentration or exposure time did not increase the efficacy of the product.

Exposure time (minutes)	<i>Bacillus subtilis</i> at 20°C (ppm POAA)											
	250 ppm			1000 ppm			2500 ppm			5000 ppm		
	CARRIER RESULTS	A ^b	B ^c	CARRIER RESULTS	A	B	CARRIER RESULTS	A	B	CARRIER RESULTS	A	B
0 minutes										0/2	2.3x10 ⁴	1.9x10 ⁴
5 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
10 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
20 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
60 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1

Exposure time (minutes)	<i>Mycobacterium terrae</i> at 20°C (ppm POAA)											
	250 ppm			1000 ppm			2500 ppm			5000 ppm		
	CARRIER RESULTS	A ^b	B ^c	CARRIER RESULTS	A	B	CARRIER RESULTS	A	B	CARRIER RESULTS	A	B
0 minutes										0/2	3.2x10 ⁴	2.1x10 ⁴
5 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
10 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
20 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1
60 minutes	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1	2/2	<1	<1

^a Number of negative carriers per number of carriers tested.

^b Plate A is the average cfu/ml of product plus neutralizer mixture.

^c Plate B is the average cfu/ml of stripper.

^d Neutralizer is 1% sodium thiosulfate and is effective in this test procedure for chemical neutralization of the test substance.

IV. Sporocidal Efficacy – US Method

The peracetic acid product was tested against *Clostridium sporogenes* using the AOAC Sporocidal Activity of Disinfectants Test with product concentrations as listed below. The product was diluted in buffer to achieve the pH 6 prior to test. The diluent tested was tap water. Test exposure time was 3, 4 or 6 hours. A result of twenty no growth tubes per twenty tubes tested is required for a passing result. Conclusion: successful results were achieved at 5000 ppm POAA with an exposure time of 6 hours.

Product Concentration*	Exposure Time	Number of no growth tubes / number of tubes tested ^b	
		Primary Subculture	Secondary Subculture
4000 ppm POAA	3 hours	20/20	0/20
	4 hours	20/20	1/20
	6 hours	19/20	20/20
5000 ppm POAA	3 hours	19/20	6/20
	4 hours	20/20	17/20
	6 hours	20/20	20/20
7000 ppm POAA	3 hours	20/20	10/20
	4 hours	20/20	11/20
	6 hours	20/20	20/20

*Diluent was tap or distilled water with pH adjusted to 6.

^b Test results reflect data achieved in three test media, Proskauer-Beck, Kirshners and Middlebrook after heat-shock treatment and reincubation for 72 hours.

OBJECTIVE:

The objective of this analysis was to evaluate the effect of hydrogen peroxide and acetic acid concentration on the sporicidal efficacy of 150 ppm peracetic acid at 40°C.

TEST METHOD:

Ecolab Microbiological Services SOP CB021-04; *Rate of Kill Antimicrobial Efficacy*. Following exposure to the formula and subsequent neutralization, spores were heat shocked for 13 minutes at 80°C before plating.

METHOD PARAMETERS:

Test Substances: Each formula was prepared using a "stock" POAA material (34.1 % POAA, 7.13 % H₂O₂ and 36.1 % acetic acid - Aldrich Chemical) to achieve 150 ppm POAA. H₂O₂ or acetic acid was then added as needed. Please refer to the data sheet attached to this report for preparation information. Since chemical analyses of solutions prepared exactly like those prepared for this study were done previously, and concentrations were found to be accurate, additional chemical analysis for this study was not performed (see MSR #960351, J. Hilgren).

Chemical Properties of Each Test Formula

Formula	Theoretical ppm POAA	Theoretical ppm H ₂ O ₂	Theoretical ppm Acetic Acid	pH
A	150	31	159	3.75
B	150	31	309	3.67
C	150	275	159	3.75
D	150	275	309	3.68
E	150	529	159	3.77
F	150	529	309	3.68

Test System: *Bacillus cereus* spore crop N1009

Test Temperature: 40°C

Exposure Times: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 hours

Neutralizer: Fluid Thioglycollate Medium

Plating Media: Dextrose Tryptone Agar

Incubation: 32°C for 48 hours

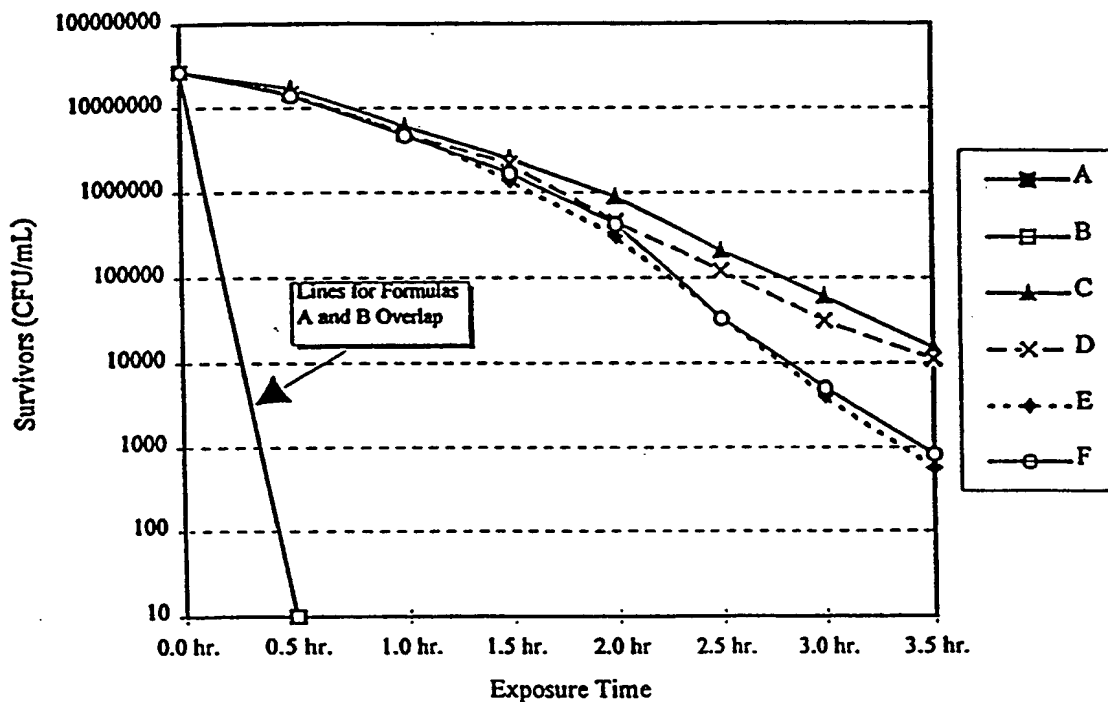
RESULTS:**Inoculum Numbers**

Organism	Inoculum Test Replicate (CFU/mL)			Average (CFU/mL)
	1	2	3	
<i>B. cereus</i> Spores	30×10^6	26×10^6	26×10^6	2.7×10^7

Reduction of *B. cereus* Spores at 40°C

Formula	Exposure Time (hours)	Survivors (CFU/mL)	Log Reduction
A Low Acetic, Low H ₂ O ₂	0.5	$<1.0 \times 10^1$	>6.43
	1.0	$<1.0 \times 10^1$	>6.43
	1.5	$<1.0 \times 10^1$	>6.43
	2.0	$<1.0 \times 10^1$	>6.43
	2.5	$<1.0 \times 10^1$	>6.43
	3.0	$<1.0 \times 10^1$	>6.43
	3.5	$<1.0 \times 10^1$	>6.43
B High Acetic, Low H ₂ O ₂	0.5	$<1.0 \times 10^1$	>6.43
	1.0	$<1.0 \times 10^1$	>6.43
	1.5	$<1.0 \times 10^1$	>6.43
	2.0	$<1.0 \times 10^1$	>6.43
	2.5	$<1.0 \times 10^1$	>6.43
	3.0	$<1.0 \times 10^1$	>6.43
	3.5	$<1.0 \times 10^1$	>6.43
C Low Acetic, Medium H ₂ O ₂	0.5	1.7×10^7	0.20
	1.0	6.0×10^6	0.65
	1.5	2.5×10^6	1.03
	2.0	9.0×10^5	1.48
	2.5	2.1×10^5	2.11
	3.0	6.0×10^4	2.65
	3.5	1.5×10^4	3.26
D High Acetic, Medium H ₂ O ₂	0.5	1.5×10^7	0.26
	1.0	4.9×10^6	0.74
	1.5	2.2×10^6	1.09
	2.0	4.6×10^5	1.77
	2.5	1.2×10^5	2.35
	3.0	3.1×10^4	2.94
	3.5	1.1×10^4	3.39
E Low Acetic, High H ₂ O ₂	0.5	1.5×10^7	0.26
	1.0	5.1×10^6	0.72
	1.5	1.4×10^6	1.29
	2.0	3.1×10^5	1.94
	2.5	3.4×10^4	2.90
	3.0	4.0×10^3	3.83
	3.5	5.6×10^2	4.68
F High Acetic, High H ₂ O ₂	0.5	1.4×10^7	0.29
	1.0	4.7×10^6	0.76
	1.5	1.7×10^6	1.20
	2.0	4.3×10^5	1.80
	2.5	3.3×10^4	2.91
	3.0	5.0×10^3	3.73
	3.5	8.1×10^2	4.52

Summary Chart
Reduction of *B. cereus* Spores at 40 C



(Note: The lower limit of detection for the test procedure was 10 CFU/mL)

CONCLUSIONS:

The sporicidal activity of 150 ppm POAA at 40°C against *Bacillus cereus* spores was most effective when in the presence of relatively low concentrations of H_2O_2 (≈ 30 ppm as in Formulas A and B). Reduced *B. cereus* sporicidal efficacy was observed using POAA with the medium and high concentrations of H_2O_2 (≈ 160 and 300 ppm as in Formulas C through F).

OBJECTIVE:

The objective of this analysis was to evaluate the effect of hydrogen peroxide and acetic acid concentration on the sporicidal efficacy of 150 ppm peracetic acid at 60°C.

TEST METHOD:

Ecolab Microbiological Services SOP CB021-04; *Rate of Kill Antimicrobial Efficacy*. Following exposure to the formula and subsequent neutralization, spores were heat shocked for 13 minutes at 80°C before plating.

METHOD PARAMETERS:

Test Substances: Each formula was prepared using a "stock" POAA material (34.1 % POAA, 7.13 % H₂O₂ and 36.1 % acetic acid - Aldrich Chemical) to achieve 150 ppm POAA. H₂O₂ or acetic acid was then added as needed. Please refer to the data sheet attached to this report for theoretical concentrations and preparation information.

Analytical Chemistry Results - A&P Methods 9403201, 9600300

Formula	Formula Properties (≈ 2 Hours Post Preparation / After 40 min. at 60°C)			
	ppm POAA	ppm H ₂ O ₂	ppm Acetic Acid	pH
A	147 / 144	31 / 33	174 / 166	3.76 / 3.67
B	145 / 144	33 / 37	346 / 346	3.71 / 3.55
C	151 / 148	277 / 281	141 / 143	3.79 / 3.69
D	151 / 151	283 / 280	301 / 291	3.70 / 3.60
E	157 / 154	526 / 514	136 / 148	3.81 / 3.71
F	160 / 159	533 / 240*	293 / 324	3.71 / 3.62

No obvious error in analysis was detected, but the result remains in question.

Test System: *Bacillus cereus* spore crop N1009

Test Temperature: 60°C

Exposure Times: 10, 15, 20, 25, 30 and 40 minutes

Neutralizer: Fluid Thioglycollate Medium

Plating Media: Dextrose Tryptone agar

Incubation: 32°C for 48 hours

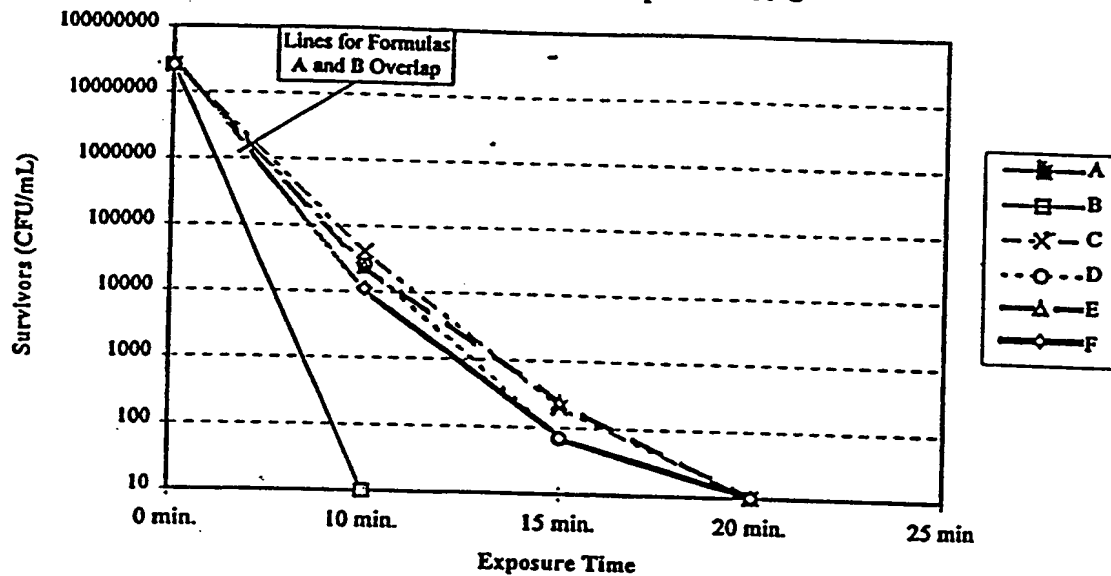
RESULTS:**Inoculum Numbers**

Organism	Inoculum Test Replicate (CFU/mL)			Average (CFU/mL)
	1	2	3	
<i>B. cereus</i> Spores	28×10^6	22×10^6	29×10^6	2.6×10^7

Reduction of *B. cereus* Spores at 60°C

Formula	Exposure Time (min.)	Survivors (CFU/mL)	Log Reduction
A Low Acetic, Low H ₂ O ₂	10	$<1.0 \times 10^1$	>6.41
	15	$<1.0 \times 10^1$	>6.41
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41
B High Acetic, Low H ₂ O ₂	10	$<1.0 \times 10^1$	>6.41
	15	$<1.0 \times 10^1$	>6.41
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41
C Low Acetic, Medium H ₂ O ₂	10	4.1×10^4	2.80
	15	2.0×10^2	5.11
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41
D High Acetic, Medium H ₂ O ₂	10	2.6×10^4	3.00
	15	7.0×10^1	5.57
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41
E Low Acetic, High H ₂ O ₂	10	2.4×10^4	3.03
	15	2.4×10^2	5.03
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41
F High Acetic, High H ₂ O ₂	10	1.1×10^4	3.37
	15	7.0×10^1	5.57
	20	$<1.0 \times 10^1$	>6.41
	25	$<1.0 \times 10^1$	>6.41
	30	$<1.0 \times 10^1$	>6.41
	40	$<1.0 \times 10^1$	>6.41

Summary Chart
Reduction of *B. cereus* Spores at 60 C



(Note: The lower limit of detection for the test procedure was 10 CFU/mL)

CONCLUSIONS:

The sporicidal activity of 150 ppm POAA at 60°C against *Bacillus cereus* spores was most effective when in the presence of relatively low concentrations of H₂O₂ (≈ 30 ppm as in Formulas A and B). A decrease in *B. cereus* sporicidal efficacy was observed using the medium and high concentrations of H₂O₂ (≈ 160 and 300 ppm as in Formulas C through F).

Further testing using Formulas A - F will be conducted at 20°C to determine the effect of H₂O₂ and acetic acid concentration on sporicidal efficacy of POAA at low temperature.

OBJECTIVE:

The objective of this analysis was to evaluate the effect of hydrogen peroxide, octanoic acid and peroctanoic acid concentration on the sporicidal efficacy of 150 ppm peracetic acid at 40°C.

TEST METHOD:

Ecolab Microbiological Services SOP CB021-04; *Rate of Kill Antimicrobial Efficacy*. Following exposure to the formula and subsequent neutralization, spores were heat shocked for 13 minutes at 80°C before plating.

METHOD PARAMETERS:**Test Substances:**

Each formula was prepared using a "stock" POAA material (33.5 % POAA, 7.03 % H₂O₂ and 37.2 % acetic acid - Aldrich Chemical) and a "stock" octanoic/peroctanoic material (11.4% octanoic, 3.4% POOA, 10.29% POAA, 3.70% H₂O₂ - Falcon 15). Hydrogen peroxide, octanoic acid or peroctanoic acid were then added as needed. Please refer to the data sheet attached to this report for preparation information. Prior to this study, chemical analyses of formulas exactly like those used for this study were conducted to determine if ingredient concentrations were close to theoretical and if they were stable over the duration of the efficacy test. Results showed ingredient concentrations to correlate with theoretical and to be stable.

Chemical Properties of Each Test Formula

Formula	Theoretical ppm POAA	Theoretical ppm H ₂ O ₂	Theoretical ppm AA	Theoretical ppm POOA	Theoretical ppm OA	pH
1	149	36	282	12	39	3.65
2	149	529	282	12	39	3.62
3	149	36	282	50	39	3.64
4	149	529	282	50	39	3.63
5	149	36	282	12	138	3.64
6	149	529	282	12	138	3.63
7	149	36	282	50	138	3.64
8	149	529	282	50	138	3.65

Test System: *Bacillus cereus* spore crop N1009

Test Temperature: 40°C

Exposure Times: 5, 10, 15, 20, 25 and 30 minutes

Neutralizer: Fluid Thioglycollate Medium

Plating Medium: Dextrose Tryptone Agar

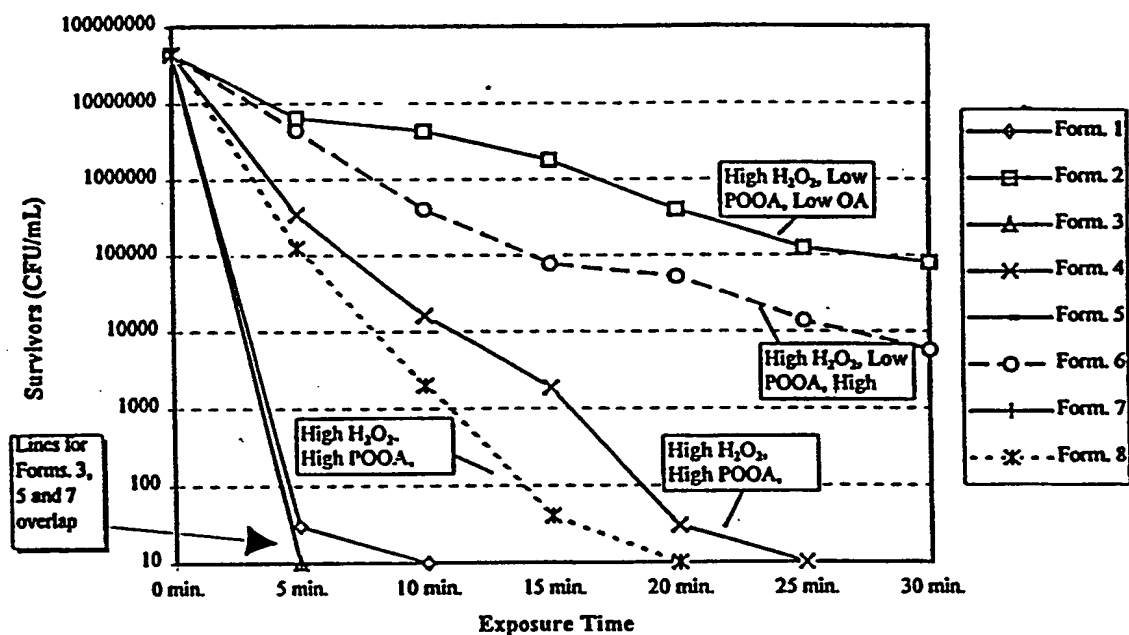
Incubation: 32°C for 48 hours

RESULTS:**Inoculum Numbers**

Organism	Inoculum Test Replicate (CFU/mL)			Average (CFU/mL)
	1	2	3	
<i>B. cereus</i> Spores	56×10^6	42×10^6	35×10^6	4.4×10^7

Reduction of *B. cereus* Spores at 40°C

Formula	Exposure Time (minutes)	Survivors (CFU/mL)	Log Reduction
1 Low H ₂ O ₂ , Low POOA, Low OA	5	3.0×10^1	6.17
	10	$<1.0 \times 10^1$	>6.64
	15	$<1.0 \times 10^1$	>6.64
	20	$<1.0 \times 10^1$	>6.64
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64
2 High H ₂ O ₂ , Low POOA, Low OA	5	6.4×10^6	0.84
	10	4.3×10^6	1.01
	15	1.8×10^6	1.39
	20	4.0×10^5	2.04
	25	1.2×10^5	2.56
	30	8.1×10^4	2.73
3 Low H ₂ O ₂ , High POOA, Low OA	5	$<1.0 \times 10^1$	>6.64
	10	$<1.0 \times 10^1$	>6.64
	15	$<1.0 \times 10^1$	>6.64
	20	$<1.0 \times 10^1$	>6.64
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64
4 High H ₂ O ₂ , High POOA, Low OA	5	3.4×10^5	2.11
	10	1.6×10^4	3.44
	15	1.9×10^3	4.36
	20	3.0×10^1	6.17
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64
5 Low H ₂ O ₂ , Low POOA, High OA	5	$<1.0 \times 10^1$	>6.64
	10	$<1.0 \times 10^1$	>6.64
	15	$<1.0 \times 10^1$	>6.64
	20	$<1.0 \times 10^1$	>6.64
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64
6 High H ₂ O ₂ , Low POOA, High OA	5	4.4×10^6	1.00
	10	4.1×10^5	2.03
	15	7.7×10^4	2.76
	20	5.3×10^4	2.92
	25	1.4×10^4	3.50
	30	5.8×10^3	3.88
7 Low H ₂ O ₂ , High POOA, High OA	5	$<1.0 \times 10^1$	>6.64
	10	$<1.0 \times 10^1$	>6.64
	15	$<1.0 \times 10^1$	>6.64
	20	$<1.0 \times 10^1$	>6.64
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64
8 High H ₂ O ₂ , High POOA, High OA	5	1.2×10^5	2.56
	10	2.0×10^3	4.34
	15	4.0×10^1	6.04
	20	$<1.0 \times 10^1$	>6.64
	25	$<1.0 \times 10^1$	>6.64
	30	$<1.0 \times 10^1$	>6.64

Reduction of *B. cereus* Spores at 40 C

(Note: The lower limit of detection for the test procedure was 10 CFU/mL)

CONCLUSIONS:

Effect of H_2O_2 :

The sporicidal activity of 150 ppm POAA at 40°C against *Bacillus cereus* spores was most effective when in the presence of relatively low concentrations of H_2O_2 (≈ 36 ppm as in Formulas 1, 3, 5 and 7). Reduced *B. cereus* sporicidal efficacy was observed using POAA with the higher concentrations of H_2O_2 (≈ 529 ppm as in Formulas 2, 4, 6 and 8).

Effects of Octanoic and Peroctanoic Acid:

The sporicidal activity of 150 ppm POAA at 40°C against *Bacillus cereus* spores increased when the concentrations of octanoic or peroctanoic acid increased. This phenomenon was clearly evident in formulas containing the high concentrations of H_2O_2 (formulas 2, 4, 6 and 8).

On a weight basis, peroctanoic acid had a greater effect on the sporicidal efficacy of 150 ppm POAA against *B. cereus* than octanoic acid. An increase of 38 ppm POAA resulted in a greater log reduction of *B. cereus* spores than an increase of 99 ppm octanoic acid. An additive effect was observed when POAA and octanoic acid were combined.

WHAT IS CLAIMED:

1. A method of sterilizing an article comprising mixing a first and a second solution to form a sterilizing solution comprising an aqueous solution of a peroxy acid, said first solution comprising a carboxylic acid, hydrogen peroxide and water, and said second solution comprising a buffering agent for pH between about 5 and 7, said sterilizing solution comprising at least 100 parts per million of peroxy acid at a pH of 5 to 7, immersing said article in said sterilizing solution for at least 5 minutes to sterilize said article.
2. The method of claim 1 wherein said solution also comprises a catalytic amount of a catalyst for peroxidation of said carboxylic acid by said hydrogen peroxide.
3. The method of claim 1 wherein said sterilizing solution has no effective amount of an organic copper or brass corrosion inhibiting compounds therein.
4. The method of claim 1 wherein said buffering agent comprises phosphate ion.
5. The method of claim 1 wherein said buffering agent comprises trisodium phosphate.
6. The method of claim 1 wherein said peroxy acid comprises a peroxy acid of at least one C1 to C12 carboxylic acid.
7. The method of claim 1 wherein said peroxy acid comprises a peroxy acid of at least one C1 to C8 carboxylic acid.
8. The method of claim 1 wherein said sterilization solution comprises 1000 to 5000 parts per million of at least one peroxy acid.
9. The method of claim 1 wherein said peroxy acid is selected from the group consisting of performic acid, peracetic acid, perpropionic acid, perbutanoic acid,

perpentanoic acid, perhexanoic acid, perheptanoic acid, peroctanoic acid,
pernonanoic acid, perundecanoic acid, and perdecanoic acid.

10. The method of claim 2 wherein said peroxy acid is selected from the group
5 consisting of peracetic acid, performic acid, perpropionic acid, perbutanoic acid,
perpentanoic acid, perhexanoic acid, perheptanoic acid, peroctanoic acid,
pernonanoic acid, and perdecanoic acid.

11. The method of claim 8 wherein said peroxy acid is selected from the group
10 consisting of performic acid, peracetic acid, perpropionic acid, perbutanoic acid,
perpentanoic acid, perhexanoic acid, perheptanoic acid, peroctanoic acid,
pernonanoic acid, perundecanoic acid, and perdecanoic acid.

12. The method of claims 2, 9 and 10 wherein said sterilizing solution has no
15 effective amount of an organic copper or brass corrosion inhibiting compounds
therein.

13. The method of claim 1 wherein said first solution also comprises a
peroxycarboxylic acid.

20

14. The method of claim 1 wherein said buffering agent comprises acetic acid
and sodium acetate.

15. An aqueous sterilant solution having a pH of from 5.0 to 7.0 comprising
25 from 100 to 10,000 parts per million of a peroxy acid and 30 to 5000 parts per
million of buffering agent.

16. An aqueous sterilant solution according to claim 15 having a pH of from 5.0
to 7.0 comprising from 100 to 10,000 parts per million of a peroxy acid, 30 to
30 5000 parts per million of buffering agent and a catalytically effective amount of
a catalyst for peroxygenation of a carboxylic acid by hydrogen peroxide.

17. An aqueous sterilant solution according to claim 15 consisting essentially of a solution having a pH of from 5.0 to 7.0 comprising from 100 to 10,000 parts per million of a peroxy acid, 30 to 5000 parts per million of buffering agent and a catalytically effective amount of a catalyst for peroxygenation of a carboxylic acid by hydrogen peroxide.
18. An aqueous sterilant solution according to claim 15 consisting essentially of a solution having a pH of from 5.0 to 7.0 comprising from 100 to 10,000 parts per million of a peroxy acid, 30 to 5000 parts per million of buffering agent, a chelating agent for cations, and a catalytically effective amount of a catalyst for peroxygenation of a carboxylic acid by hydrogen peroxide.
19. The method of claim 1 comprising mixing a first and a second solution to form a sterilizing solution comprising a peroxy acid, said first solution comprising a carboxylic acid, hydrogen peroxide and water, and said second solution comprising a buffering agent for pH between about 5 and 7, said sterilizing solution comprising at least 100 parts per million of peroxy acid at a pH of 5 to 7, immersing said article in said sterilizing solution for at least 5 minutes to sterilize said article, said first solution and second solution being free of organic anti-corrosion agents for brass and/or copper, and said article comprising a medical article having parts made of at least two materials selected from the group consisting of metals, polymers and rubbers.
20. The method of claim 1 wherein said carboxylic acid is at least one carboxylic acid selected from the group consisting of aliphatic carboxylic acids, aromatic carboxylic acids, mono- and di-hydroxycarboxylic acids diacids, and peroxycarboxylic acids is present within said first solution.
21. The method of claim 1 wherein said carboxylic acid is at least one carboxylic acid selected from the group consisting of hydroxy acids and dicarboxylic acids.

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61L2/18 A01N37/16 //A61L101/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61L A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 720 983 A (MALONE JOSEPH WILLIAM GERARD) 24 February 1998 (1998-02-24)	1-4, 6-13, 15-21
Y	column 1, line 8 - line 13 column 3, line 21 - column 4, line 58 example 1	1,5,14
X	US 5 077 008 A (KRALOVIC RAYMOND C ET AL) 31 December 1991 (1991-12-31) cited in the application column 1, line 67 - column 2, line 29 column 4, line 46 - column 5, line 26	1,4, 6-11,13
Y	EP 0 518 450 A (ABBOTT LAB) 16 December 1992 (1992-12-16) column 4, line 49 - column 5, line 1	1,5
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 March 2000

Date of mailing of the international search report

03/04/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Diederer, J

INTERNATIONAL SEARCH REPORT

Inter. Appl. No.

PCT/US 99/27699

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>WO 95 32783 A (BIOSEPPA INC ;JUNGBAUER ALOIS (AT); LETTNER HANS PETER (AT)) 7 December 1995 (1995-12-07) page 1, line 5 - line 10 page 5, line 19 - line 27 example 1</p>	1,14
A	<p>US 4 418 055 A (ANDERSEN HAROLD W ET AL) 29 November 1983 (1983-11-29) column 8, line 32 - line 36</p>	5

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No

PCT/US 99/27699

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5720983 A	24-02-1998	AT 179569 T	15-05-1999
		AU 686127 B	05-02-1998
		AU 5820394 A	15-08-1994
		BR 9406256 A	09-01-1996
		CA 2153396 A	21-07-1994
		CN 1117705 A	28-02-1996
		CZ 9501756 A	17-01-1996
		DE 69418305 D	10-06-1999
		DE 69418305 T	25-11-1999
		EG 20536 A	31-07-1999
		EP 0677990 A	25-10-1995
		ES 2133534 T	16-09-1999
		FI 953351 A	07-07-1995
		WO 9415465 A	21-07-1994
		GR 3030857 T	30-11-1999
		HR 940015 A	31-08-1996
		HU 72108 A,B	28-03-1996
		IL 108120 A	30-09-1997
		JP 2843442 B	06-01-1999
		JP 8500843 T	30-01-1996
		NO 952714 A	07-07-1995
		NZ 259408 A	26-11-1996
		PL 309723 A	13-11-1995
		SI 9300695 A	31-12-1994
		SK 87995 A	08-05-1996
		ZA 9400095 A	16-11-1994
US 5077008 A	31-12-1991	US 4731222 A	15-03-1988
		US 5391360 A	21-02-1995
		US 5374394 A	20-12-1994
		US 5407685 A	18-04-1995
		US 5350563 A	27-09-1994
		US 5552115 A	03-09-1996
		US 5091343 A	25-02-1992
		US 5217698 A	08-06-1993
		US 5225160 A	06-07-1993
		AT 63222 T	15-05-1991
		CA 1273774 A	11-09-1990
		EP 0232170 A	12-08-1987
		GR 3001926 T	23-11-1992
		JP 1745511 C	25-03-1993
		JP 4030865 B	22-05-1992
		JP 62186860 A	15-08-1987
		US 4892706 A	09-01-1990
		US 5037623 A	06-08-1991
		US 5116575 A	26-05-1992
		US 5209909 A	11-05-1993
EP 0518450 A	16-12-1992	US 5302345 A	12-04-1994
		AU 1390192 A	28-05-1992
		AU 2313388 A	13-02-1989
		DK 13590 A	14-03-1990
		EP 0376962 A	11-07-1990
		IL 87127 A	13-05-1993
		JP 3502050 T	16-05-1991
		MX 173044 B	31-01-1994
		NO 900206 A	15-01-1990
		NZ 225423 A	27-11-1990

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/US 99/27699

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0518450 A		WO 8900430 A	26-01-1994
		ZA 8805035 A	29-03-1989
WO 9532783 A	07-12-1995	AU 685954 B	29-01-1998
		AU 2658295 A	21-12-1995
		CA 2191351 A	07-12-1995
		EP 0762919 A	19-03-1997
		JP 10501336 T	03-02-1998
		US 5676837 A	14-10-1997
US 4418055 A	29-11-1983	DE 2927016 A	24-01-1980
		ES 482393 A	01-07-1980
		ES 490575 D	16-02-1981
		ES 8102807 A	16-05-1981
		FR 2442634 A	27-06-1980
		GB 2025229 A, B	23-01-1980
		GB 2084022 A, B	07-04-1982
		JP 55014094 A	31-01-1980
		SE 7906037 A	13-01-1980
		US 4276263 A	30-06-1981
		US 4284599 A	18-08-1981